Continuous-Scan Phased Array Measurement Methods for Turbofan Engine Acoustic Testing, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

ATA Engineering, Inc., (ATA) proposes an SBIR project to advance the technology readiness level (TRL) of a method for measuring phased array acoustic data for complex distributed noise sources using continuously moving (referred to here as continuous-scan, or CS) microphones in conjunction with state-of-the-art phase-referencing techniques. The proposed project aims to develop two novel modules to the existing suite of tools for CS acoustic measurements: (1) A continuous-scan beamforming (CSBF) tool for arrays located in the mid to far field to perform source diagnostics in low-SNR wind tunnel environments., and (2) An azimuthal modal decomposition tool for near-field arrays having partial azimuthal coverage, enabling acoustical holography without full source enclosure. The first module will enable small-aperture beamforming (BF) arrays to adopt the CS method, resulting in reduced maximum sidelobe levels and higher-quality BF images that approach the theoretical limits associated with the theory. The second module will enable CS near-field arrays that avoid the requirement for full coverage, greatly simplifying the array coverage requirements and making acoustical holography systems more practical in testing facilities. In Phase I, ATA will demonstrate feasibility of the methods through application to existing acoustic measurement data sets. In Phase II, the methods will be optimized and rigorously validated through experiments using small-scale turbofan engine models. Ultimately, we will transition these methods to NASA and industry stakeholders for adoption in relevant facilities.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: As part of Strategic Thrust 3: Ultra-Efficient Commercial Vehicles, in the Strategic Implementation Plan issued by the Aeronautics Research Mission Directorate (ARMD), NASA establishes noise

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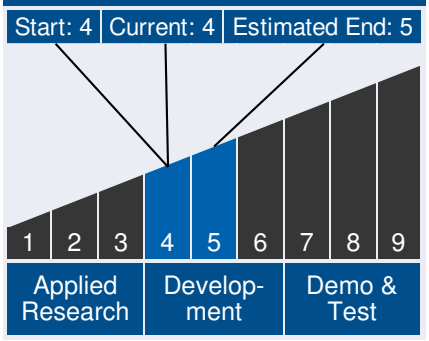
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

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improvement margins (relative to the FAA Stage 4 noise limit) of –32 dB, –42 dB, and –52 dB, for N+1, N+2, and N+3 future aircraft technology generations, respectively. The plan also calls for "tools and technologies to reduce turbofan-thrust-specific fuel consumption, propulsion noise, and emissions." By improving the quality and efficiency of acoustic measurements taken in wind tunnels, the proposed measurement and modeling technology will provide NASA with new capabilities to lead the development of next-generation propulsion systems, airframes, and efficiency technologies. Multiple NASA research centers operate wind tunnels that support aeronautical acoustics research, including the Unitary Plan Wind Tunnels at NASA Ames, the 14' x 22' subsonic tunnel at NASA LaRC, and the 9' x 15' LSWT and five others at NASA GRC.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Community noise exposure continues to be a significant issue near airports, confining growth and impacting quality of life and health of those affected. To counteract growing exposure, ever more stringent noise standards are expected to be implemented by regulatory agencies in the certification of aircraft. These standards are predicated on the discovery of new technologies aimed at reducing aircraft and engine noise. Further noise performance improvements will likely be asymptotic, with incremental improvements resulting in only modest noise reduction. Thus, innovative measurement technologies to better identify and diagnose noise sources within the aircraft and engine are necessary, particularly for the subscale-size test articles and low-SNR environments of wind tunnel testing. ATA believes there is a significant market opportunity for the enhanced CS toolset through adoption at engine manufacturers, airframers, and international aviation authorities. Beyond aviation, CS tools and methods will be applicable to wind turbine, automotive, and industrial noise.

Management Team *(cont.)*

Principal Investigator:
- Parthiv Shah

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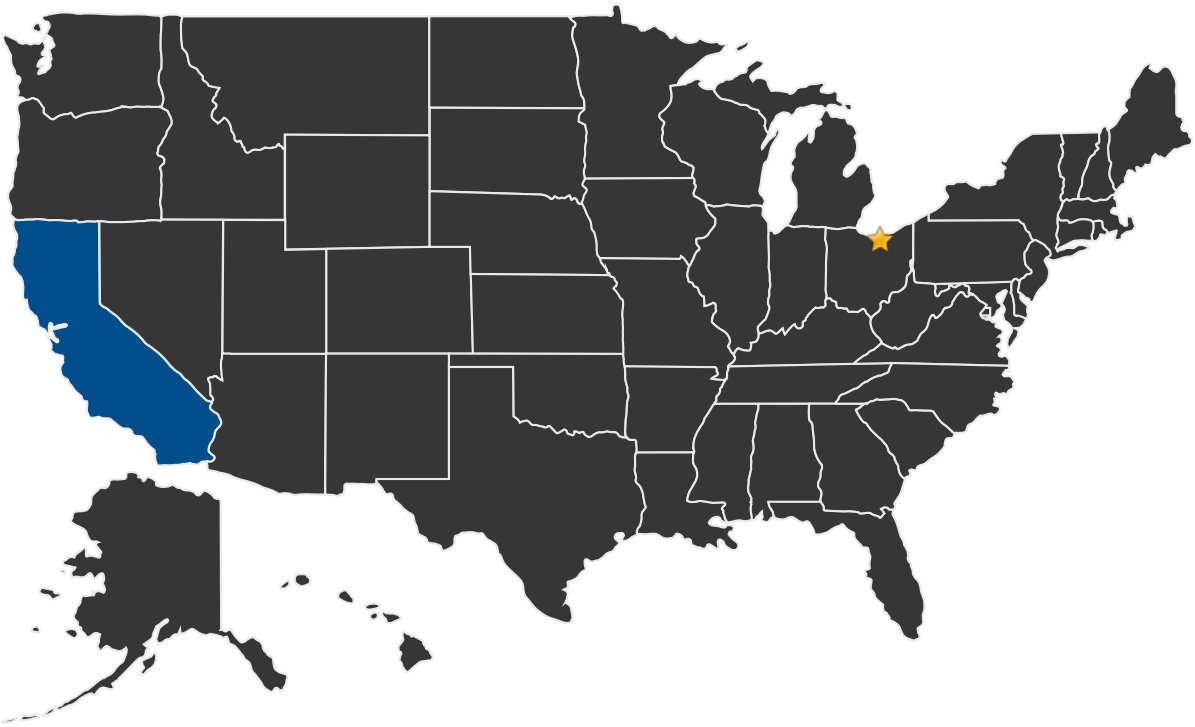
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Glenn Research Center

Other Organizations Performing Work:

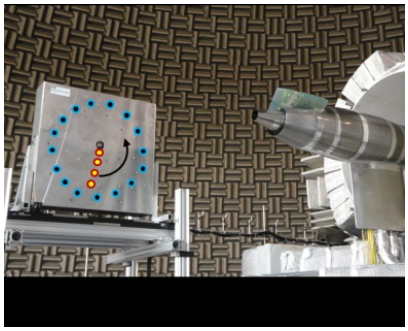
- ATA Engineering, Inc. (San Diego, CA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23512)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

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Potential Applications

As part of Strategic Thrust 3: Ultra-Efficient Commercial Vehicles, in the Strategic Implementation Plan issued by the Aeronautics Research Mission Directorate (ARMD), NASA establishes noise improvement margins (relative to the FAA Stage 4 noise limit) of –32 dB, –42 dB, and –52 dB, for N+1, N+2, and N+3 future aircraft technology generations, respectively. The plan also calls for "tools and technologies to reduce turbofan-thrust-specific fuel consumption, propulsion noise, and emissions." By improving the quality and efficiency of acoustic measurements taken in wind tunnels, the proposed measurement and modeling technology will provide NASA with new capabilities to lead the development of next-generation propulsion systems, airframes, and efficiency technologies. Multiple NASA research centers operate wind tunnels that support aeronautical acoustics research, including the Unitary Plan Wind Tunnels at NASA Ames, the 14' x 22' subsonic tunnel at NASA LaRC, and the 9' x 15' LSWT and five others at NASA GRC.